the head of Frobisher Bay. The fossils are well preserved and many of them are now in the U. S. National Museum. The paper gives a brief summary of the geology of the region as gathered from reports by those who have either visited it or have examined collections from it. The Lower Silurian fossils so far collected are of Trenton and Utica age, and strata containing these faunas are widespread in eastern Arctic America. So far as known they rest upon the pre-Cambrian rocks and are overlain by beds of Niagara age. Of the 72 species known from the locality of Silliman's Fossil Mount 28 are restricted to it. Of the remaining 54 species, 41 are found in the Manitoba-Minnesota-Wisconsin region and 17 in the New York-Ottawa region. A comparison of the 54 species found elsewhere with those from definite stages in Minnesota shows that 10 are found in the Birds-eye (Lowville), 17 in the Black River, 38 in the Galena, and 11 in the Cincinnatian.

The close resemblance of the Minnesota Galena to the Silliman's Fossil Mount formation may in large part explain the close identity of the faunas. In the summary, page 175, the author says: "The Baffin Land fauna had an early introduction of Upper Silurian genera in the corals Halysites, Lyella and Plasmopora. In Manitoba similar conditions occur in the presence of Halysites, Favosites, and Diphyphyllum. The Trenton fauna of Baffin Land shows that corals, brachiopods, gastropods, and trilobites have wide distribution and are therefore less sensitive to differing habitats apt to occur in widely separated regions. On the other hand the cephalopods and particularly the pelecypods, indicate a shorter geographical range. The almost complete absence of Bryozoa in the Baffin Land Trenton contrasts strongly with the great development of these animals in Minnesota and elsewhere in the United States."

The paper is a valuable addition to our knowledge of the Ordovician faunas of eastern Arctic America.

R. D. GEORGE.

The Freshwater Tertiary Formations of the Rocky Mountain Region. By W. M. DAVIS. Proceedings of the American Academy of Arts and Sciences, Vol. XXXV, No. 17, March, 1900.

In this very timely paper Professor Davis gives voice to a growing change of opinion regarding the specific mode of origin of the most

characteristic class of formations of the Rocky Mountain Tertiaries. During recent years not a few geologists, here and there, have expressed a disposition to regard some of the deposits usually assigned to lakes as the products of stream action or "sheet wash," or of a combination of these with lake deposition. To the reviewer, who is among these dissenters, the favorite illustration of such modes of deposition is the present and recent accumulation in the Great Valley of California where several forms of subaërial aggradation are conjoined with lacustrine and marine deposition. This newer mode of interpretation has been applied to a notable series of formations distributed at intervals from the Medina, and even the Keweenawan, to the Lafayette and the recent deposits of the great basins of all the continents, particularly the arid basins. The great red terranes, with their associated products of desiccation and saline concentration, especially, have seemed to the reviewer attributable to such combined action, since a basin of saline concentration carries in its very terms the idea of a basin of detrital lodgment whose central part may be an area of subaqueous deposition but whose border is almost inevitably a zone of subaërial accumulation. The doctrine of non-lacustrine basin-aggradation, as it lies in the mind of the reviewer, has its most distinctive application to tracts of relative aridity, for it is in these, chiefly, that the conditions of subaërial lodgment preponderate over the conditions of subaqueous deposition, except in the case of aggrading river bottoms near base level which are undergoing a depression of gradient by deformation. In an arid basin-tract the precipitation is likely to be greatest on the elevated rim, and there it is often spasmodic, taking the form of cloudbursts and similar intensified forms. The gradient is also highest, as a rule, in the rim zone. These form a combination of agencies which result in an exceptional transportation of detritus down the slopes of the basin rim followed by a marked reduction of power of transportation as the flatter part of the basin is reached; for there the flood loses its power by lowered gradient, by spreading, by absorption, and by evaporation. Deposition is the usual consequence. In a humid region, the conditions are largely reversed; the streams augment in volume as they flow over the basin-plain and the power of transportation is more or less fully maintained. If the basin be a closed one the accumulated waters arising from the excess of precipitation over evaporation soon cover the basin floor with a lake which occupies the territory that in an arid region would be

covered in large part with subaërial detritus. In a humid region with free drainage no great thickness of detritus can usually be built up on the floor of a basin without increasing the gradient so as to suspend the process of aggradation, unless movements of deformation or changes of sea-relationship intervene to renew and perpetuate the conditions of aggradation. This of course may happen, but it is rather to be classed as an accidental intervention than as a systematic process.

The presumptions therefore seem to lie on the side of lacustrine deposition, with incidental fluvial aggradation, in humid regions, while in arid regions they lie on the side of fluvial aggradation, with incidental lacustrine deposition. To the reviewer, therefore, the question has a specific climatic relationship and this relationship seems much the most important phase of the subject. Given the same humidity, and the ratio of lacustrine to fluvial deposition is dependent on surface adjustments of a local nature. Given the same surface adjustments, and the ratio of lacustrine to fluvial deposition is dependent on states of humidity or aridity. But the humidity or the aridity of an area large enough to have geological importance, implies atmospheric states that are a function of the whole atmosphere, and of its modes of circulation, and hence has far-reaching significance.

If these considerations have any validity, the question which Professor Davis pointedly raises regarding the Rocky Mountain Tertiaries, as a specific example of the class under question, deserves the most critical attention. The value of an academic discussion, which is often unwisely underrated by the working field geologist, lies chiefly in deploying the problem and laying the groundwork for discriminative observations. Professor Davis seems to be altogether correct in pointing out a lack of critical observation and interpretation in most previous studies of the Tertiaries in question, and his discussion can hardly fail to call forth incisive studies upon these formations. Obviously their true character can only be determined by such critical field studies. A first step is the establishment of criteria of discrimination between lacustrine and fluvial deposits; by no means an easy task where the products of relatively shallow lakes are to be distinguished from those of rivers, which is really the critical case. It is not clear that the criteria given in the paper will always hold good, but there are several additional ones that may be brought into service, such as the distribution of the remains of land animals in the midst of

the basin, the occurrence of marsh-formed or land-formed lignites in similar situations, the interstratification of beds of gypsum or other desiccation products, and analogous criteria that imply aërial conditions. T. C. C.

The Crystal Falls Iron-Bearing District of Michigan. By J. MORGAN CLEMENTS and HENRY LLOYD SMYTH, with a chapter on the Sturgeon River Tongue by William Shirley Bayley and an Introduction by Charles Richard Van Hise. U. S. Geological Survey. Monograph XXXVI. Washington, 1899.

This report is the third in a series of four monographs on the iron-bearing district of the Lake Superior Region. Two having been published previously: one on the Penokee district (Monograph XIX). The other on the Marquette district (Monograph XXVIII). The fourth, on the Menominee district, is to follow.

The Crystal Falls district was divided areally, the western half being studied by Mr. Clements and the eastern half by Mr. Smyth, and the Sturgeon River Tongue by Mr. Bayley. The investigation was conducted under the charge of Mr. Van Hise, who sums up the general results in an introductory chapter. The district embraces 840 square miles. As pointed out in the introduction the rocks belong to the Archean and Algonkian. The latter consisting of a Lower Huronian and an Upper Huronian separated by unconformity. The Archean is believed to be wholly igneous in origin, it occupies a broad area in the eastern part of the district and has not been closely investigated. Several smaller areas occur within parts of the region carefully studied. Owing to the readily decomposable nature of the rocks in places and to the drift mantle the detail character of the formations is unknown for part of the area described by Clements, and in the belt worked by Smyth the rock surface is almost wholly concealed by glacial deposits and vegetation. It will be seen under what adverse circumstances the field work was carried forward, and how much credit is due the geologists who have brought to light so much valuable information from so unpromising a region.

The Lower Huronian consists of quartzite, dolomite, slate, a volcanic formation, and some schists. The series has a minimum thickness of 2200, and a possible maximum thickness of 16000 feet. The sediments probably nowhere exceed 5000 feet in thickness. The Upper Huronian